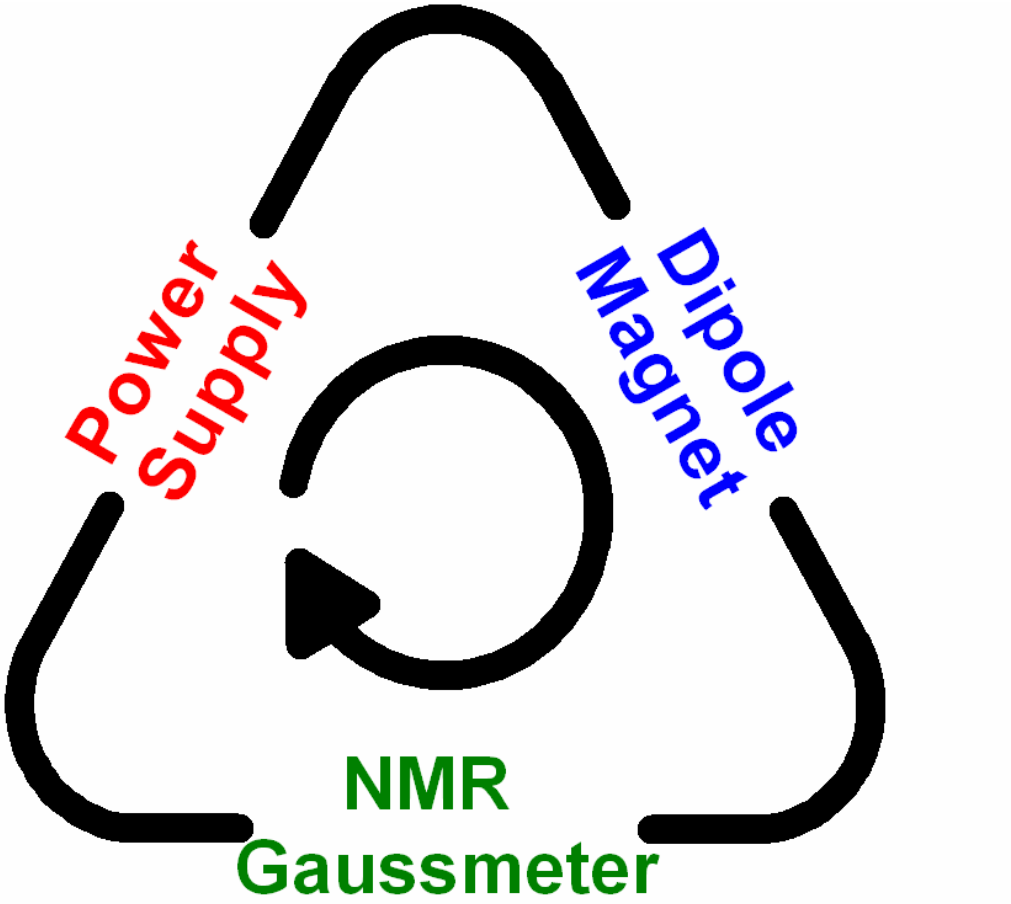


Dipole Regulation

Monday Meeting Talk
Chuck Schmidt
Nov. 3, 2003

1. **Bruker Power Supplies**
2. **Dipole Magnets – 45^{o} and 90^{o} dipoles**
3. **NMR**
4. **Regulation Loop**

Bruker Power Supplies

- **25 V – (8 to 15 V operation)**
- **5 A – (3.1 to 4.0 A operation)**
- **100 ppm stability (10 ppm for 1 min) – Operation at least this good**
- **16 bit DAC/ADC (15 ppm) resolution)**
- **Least Significant Bit ~ 76 microamps**
- **Resolution: 76 uA / 3.2 A = 2.4 e-5**

Dipole Magnets

- **"Estimations on stability of WB beam line elements' currents"**
  A.Burov, S.Seletsky, A. Shemyakin 15-Oct-03
  Based on max angle in the cooling section of 0.01 mrad.

  Dipoles: B·dl ~ 7.0e-5 stability

- **Steel: Thermal expansion ~ 1.1e-5 / ^{O}C**

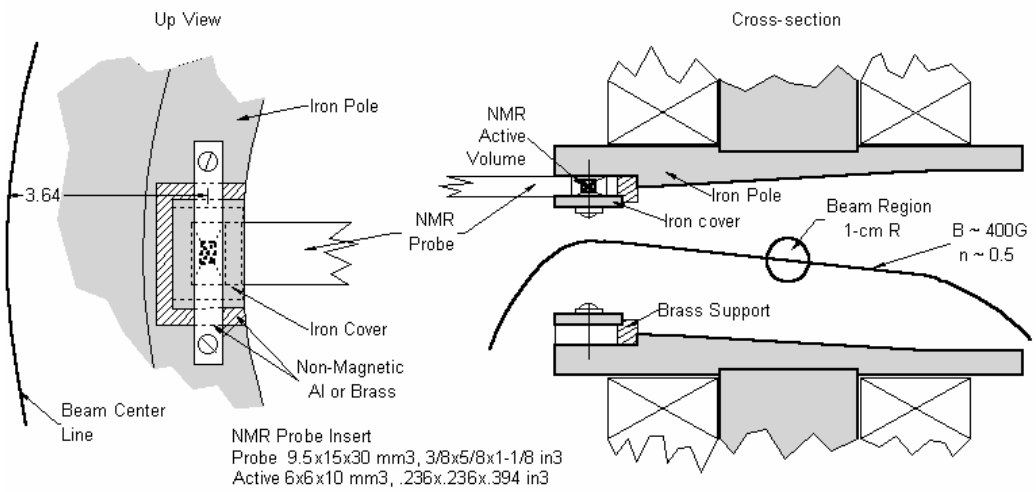
- **Operating values:**

	45^{O} dipoles		90^{O} dipoles	
Energy (MeV)	Field (G)	Current (A)	Field (G)	Current (A)
3.50	262	3.2	395	3.1
4.35	320	4.0	481	3.9

- **Field stability < ~300G x 7e-5 = 21e-3G or <u>20 mG</u>**

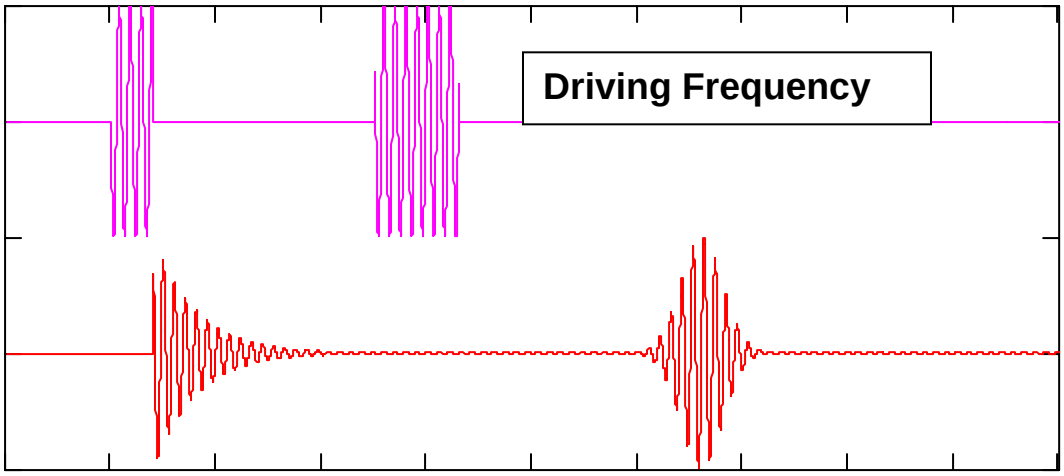
- **Least Significant Bit ~76 uA ~<u>6 mG</u>**

- **45^{O} dipoles – 90^{O} bends:**
  - **Homogeneous field**
  - **NMR probe at inside radius of beam chamber on midplane**
  - **Resulting field errors for at NMR corrected with figure-8 coils**
- **90^{O} dipoles – 180^{O} bend:**
  - **Gradient field – n = 0.5±0.05**
  - **Special correction at pole edge for NMR**


Up View
Cross-section
Iron Pole
3.64
NMR
Probe
Iron Cover
Non-Magnetic
Al or Brass
Beam Center
Line
NMR
Active
Volume
Iron Pole
Iron cover
Beam Region
1-cm R
B ~ 400G
n ~ 0.5
Brass Support
NMR Probe Insert
Probe 9.5x15x30 mm3, 3/8x5/8x1-1/8 in3
Active 6x6x10 mm3, .236x.236x.394 in3

NMR Gaussmeter

- **Range: 250 to 600 G**
- **12 channels**
- **Water sample measuring the “spin-echo” signal**



“spin-echo” signal

$B = \gamma f$
Gyromagnetic ratio, γ =42.57639 MHz/T
300G=1.27729 MHz

- **Regulation Loop Sensitivity:**
  With field gradient less than 0.2G/cm
  <10 ppm
  With field gradient 0.4G/cm
  ~30 ppm

- **Signal-to noise ~ B^2**
  260G marginal
  320G significantly better

Regulation Loop

Closes loop between NMR readings and Power Supply setting through software:

- **Average 10 readings of each NMR channel (dipole reading). Maintain a running average of the last 10 field readings.**
- **If any reading exceeds 50 mG consider bad and ignore in average.**
- **If average exceeds +- 10 mG, increase or decrease setting of dipole PS by 1 LSB (~76 uA ~6 mG)**

Console operations:

To use the regulating loop

1. Set the PS to desired value

2. Enter expected field for NMR D/A and start NMR search by clicking first star and on.

3. NMR will search (?) in sequence with other channel tasks and give field (A/D) if found. Field must be within ~10G of setting.

3. Adjust current of PS or NMR D/A setting until field and setting agree (within 10mG)

4. Click last star and PLUS to start regulation.

5. If all is well both stars will remain green. (If red, regulation is off.)

6. After 10-cycle average, if NMR setting and reading differ by +-10mG, PS will be corrected

7. If too large an error occurs (+-50 mG or more) the regulation may drop out and need restarting.

- **To turn off regulation, interrupt last star and MINUS**

- **Small changes <50mG can be made by changing the NMR D/A setting while regulating.**

- **Large changes made through the PS may trip off the NMR reading and will require resetting the NMR.**

- **Dipole-NMR regulation should maintain the NMR field reading (A/D) to within +-10 mGauss of the desired field setting (D/A), ie. +-3.5 e-5 or 7.0e-5.**